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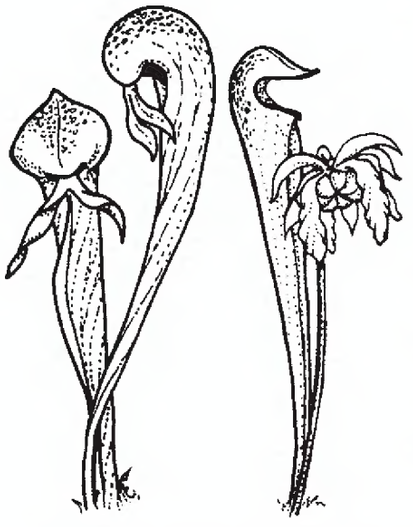

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Front Cover: Flowering African *Aldrovanda vesiculosa* from Botswana in an indoor culture. Photo by Lubomír Adamec. Article on page 64.

Back Cover: A cluster of *Nepenthes ampullaria* lower pitchers growing in Gunung Mulu National Park, Borneo. Photo taken by Richard Nunn. Article on page 47.

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Additional taxonomic features of *Pinguicula chilensis*

Aymeric Roccia • Chambéry • France • aymeric.roccia@live.fr

Keywords: *Pinguicula chilensis*, *Pinguicula antarctica*, *Pinguicula australandina*.

Recently, Gluch (2017) synonymized the name *Pinguicula chilensis* Clos with *P. antarctica* Vahl and described two new species *P. australandina* Gluch and *P. nahuelbutensis* Gluch, referring to the plants previously known as "*P. chilensis*".

The main reason for which Gluch (2017) considered that the isotype of *Pinguicula chilensis* (specimen *Gay 169* (P photo!), designated as the lectotype by Dominguez *et al*. (2017) and held at the Muséum national d'Histoire naturelle (P), in Paris) is in fact *P. antarctica*, is the length of the fruiting scapes. On that specimen, Gluch (2017) measured 9.5 cm for the longest scape, but considered that scapes of *P. chilensis* (referred to as *P. australandina*) can only reach 2-5 cm long. This range is based on Ernst (1961), and was adopted literally by Casper (1966), and later by Lampard *et al*. (2016). However, the variability of *P. chilensis* has been further investigated since Casper's monograph of the genus *Pinguicula* (Casper 1966). For example, Rodríguez *et al*. (2000) extended the range of the flowering scape length to 2-8 cm. Recently, Michail Belov published pictures from the Laguna del Maule, in Talca province in Chile (Figs. 1 & 2). Those individuals display the typical lilac flowers with long conical spur of *P. chilensis*, as described by Clos (1849), Ernst (1961), and Casper (1966). Moreover, the Laguna del Maule represents one of the northernmost location of this species, very far from any populations of the *P. antarctica* distribution range known to date. No doubt that those specimens clearly belong to *P. chilensis sensu* Ernst (1961) and Casper (1966). Fortunately,

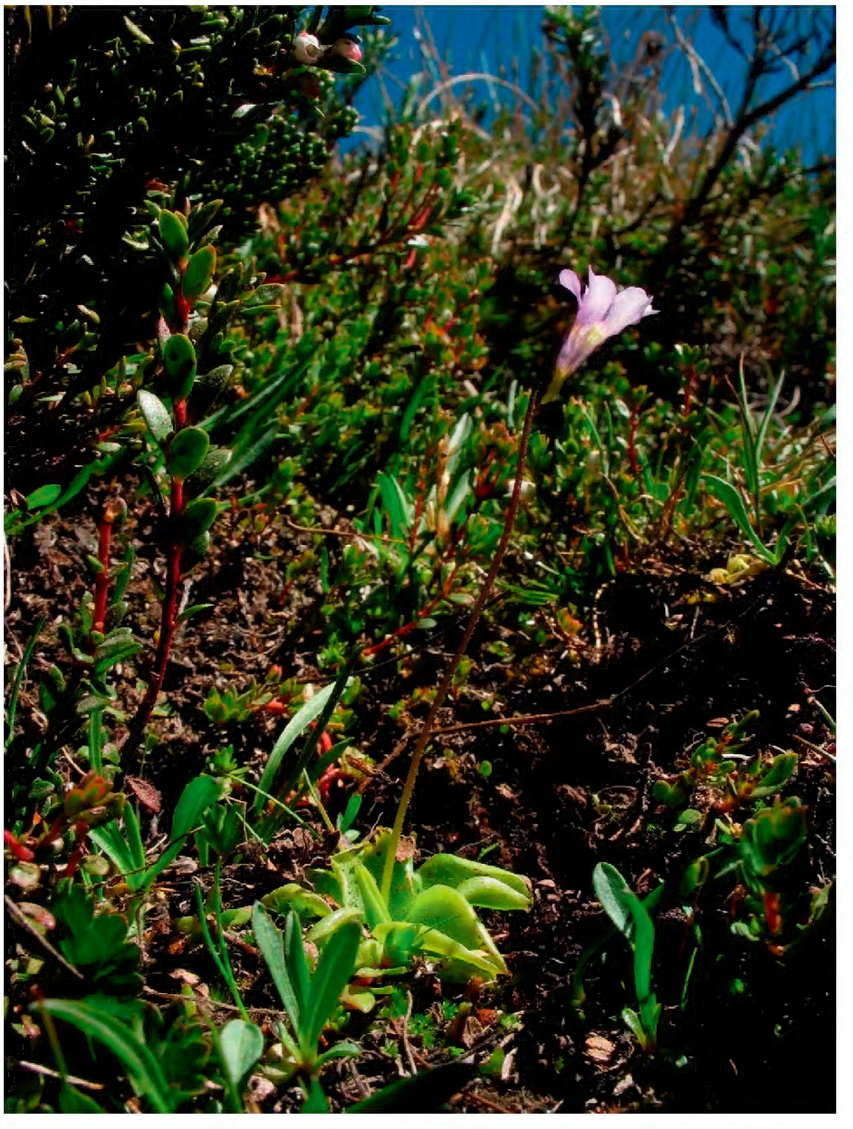

Figure 1: A flowering *Pinguicula chilensis* in its habitat at the Laguna del Maule, Provincia de Talca, Chile. Photograph by Michail Belov.

Figure 2: *Pinguicula chilensis* flowers and entire flowering plants collected at the Laguna del Maule, Provincia de Talca, Chile. Photograph by Michail Belov.

Michail Belov also took pictures of the flowering scapes against a ruler (Fig. 2). Most scapes are not removed entirely, as the scape bases are mostly violet whereas they are supposed to be green when fully pulled out. However, the longest entire scape is 7 cm long. In addition, although unmeasured, the scape shown on Figure 1 looks even longer. In this respect, the measure of 9.5 cm on the lectotype should not be regarded as inconsistent with *P. chilensis* characteristics.

Nonetheless, a matter of doubt could remain because of the location of Gay's collection which is used as lectotype (*Gay 169* (P)). This plant originates from "el Corral, cerca de Daglipulli" (Valdivia province). Corral is a coastal city, near Valdivia, and Daglipulli is a small village close to La Unión (Ranco province), situated at an elevation of *ca.* 80 m a.s.l. Such environmental conditions are not the expected ones for *Pinguicula chilensis* (Casper 1966; Rodriguez *et al.* 2000; Lampard *et al.* 2016). However, a small mountain range called Cordillera Pelada occurs between both localities, peaking at 1042 m a.s.l. Rodriguez *et al.* (2000) mentioned that *P. chilensis* can be found at elevations as low as 1000 m a.s.l. and *Pinguicula chilensis* is considered to occur at lower elevations to the south, as climate becomes colder (Lampard *et al.* 2016). It would then not be inconceivable to find a location at such low elevation at the latitude of Corral.

In addition, Gluch (2017) discarded the possibility that this species could occur on the Cordillera Pelada based on the fact the peat-bogs occurring on this mountain range are made of "typical Antarctic vegetation consisting of the dominating species *Donatia fascicularis* [Stylidiaceae], *Astelia pumila* [Asteliaceae], *Sphagnum acutifolium* [Sphagnaceae], and *Tribeles australis* [Escalloniaceae]. In between this vegetation, Reiche stated that *Carpha viridis* [Cyperaceae], *Pinguicula chilensis*

[Lentibulariaceae], *Acaena pumila* [Rosaceae], *Drosera uniflora* [Droserceae], and *Schizaea fistulosa* [Schizaeaceae] can be found". However, Rodriguez *et al.* (2000) stated that *P. chilensis* does occur among *Donatia fascicularis*, *Astelia pumila*, *Sphagnum magellanicum*, and *Tribeles australis*.

Finally, a body of noteworthy elements can be noticed when reviewing the original description of *Pinguicula chilensis* (Clos 1849). Firstly, both *P. chilensis* and *P. antarctica* are described in this work, thus the author knew both species at that time. Secondly, Clos (1849) mentioned about *Pinguicula chilensis*: "bohordos [...] terminados por una sola flor poco colgante" (scapes are terminated by a single flower only shallowly inclined), although he added that "se habian ya concluidas las flores" (flowers were already faded). With little doubt, Clos seems to have described the skyward-facing flower of *P. chilensis*, as opposed to *P. antarctica* which produces flowers held horizontally. This description also suggests that Clos has observed *P. chilensis* flowers and its diagnostic characters such as the spur shape, but for an unknown reason, he did not describe it. One can only imagine that Clos really knew what he was doing when describing *P. chilensis*.

All-in-all, those reasons support the fact that Clos' *Pinguicula chilensis* is a distinct species from Vahl's *P. antarctica* and that Gluch's *P. australandina* is a later synonym of *P. chilensis* Clos based on a different interpretation of the morphological and ecological variations of that species:

Pinguicula chilensis Clos = *P. australandina* Gluch, *syn. nov.*

Acknowledgements: The author would like to thank Michail Belov for kindly providing his pictures and giving the authorization to publish them in this article.

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An account of *Nepenthes ampullaria* Jack

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Introduction

One of the most iconic and unique species of *Nepenthes*, *N. ampullaria* (Fig. 1) is widespread being found throughout South East Asia. As a young child enthusiastically reading everything available on Carnivorous Plants, the author recalls the amazement at seeing the clusters of tub shaped pitchers on the floor of the Bornean jungle, in a 1960s National Geographic. Many years later this amazement had not diminished on the first sight of this species in the field, just outside of Kuching, in Sarawak. Few fail to be impressed with *N. ampullaria* in cultivation or in the field and Lloyd's (1942) translation of Troll's (1932) first encounter with this species, sums up well how most feel when first confronted with *N. ampullaria*.

> "I came across *N. ampullaria* among the massive vegetations [*sic*] of a swamp-forest on the island of Siburut [*sic*] off the west coast of Sumatra. It was a fabulous, unforgettable sight. Everywhere, through the network of lianas the peculiarly formed pitchers of this species gleamed forth, often in tight clusters; and, most remarkably, the muddy, moss overgrown soil was spotted with the pitchers of this plant, so that one got the impression of a carpet."

Figure 1: An early botanical illustration of *Nepenthes ampullaria*. This illustration was included in Korthals' 1839 monograph of the genus *Nepenthes*.

Apart from the unique shape of the pitchers, this species possesses other qualities that add to its fascination. Over the entirety of its range, *Nepenthes ampullaria* shows spectacular diversity in pitcher coloration, even though morphologically there is very little variation. It is also one of a small number of *Nepenthes* species that have evolved away from being solely carnivorous and can supplement their diet with forest canopy detritus.

Nepenthes ampullaria is an extraordinary member of the *Nepenthes* family and the aim of this short paper is to introduce the reader to a more in-depth appreciation of this wondrous plant.

Etymology

The specific epithet is derived from the Latin ampulla (flask), referring to the unique urceolate shape of the lower pitchers (Figs. 2–4, and Back Cover).

Figure 2: *Nepenthes ampullaria* growing at Kent Ridge, Singapore. Jack first discovered this species in Singapore in 1819. Photo taken by Richard Nunn.

Botanical History

Nepenthes ampullaria was discovered in Singapore, in 1819 by Dr. William Jack. Jack was employed by the East India Company as a surgeon in India, where he corresponded extensively with botanist Nathaniel Wallich. In 1818, he accompanied Stamford Raffles to Sumatra where he extensively documented the rich flora of that region until his death in 1822. Much of his work, including manuscripts, drawings, and collections were destroyed by fire in 1824. He died at Bencoolen (Bengkulu) in Sumatra on 15 September 1822. Before his death, Jack authored Descriptions of Malayan Plants 1820-1822, which were originally published in Malayan Miscellanies, in which he described *N. ampullaria*, and these were reprinted in various forms at later dates. One of these reprints containing the description of *N. ampullaria*, was formally published by William Jackson Hooker (1835), in Companion to the Botanical Magazine. This is now the accepted formal publication of this species.

Description
(Reproduced from Cheek and Jebb (2001))

Terrestrial climber to 15 m tall, with many terrestrial and some aerial rosettes. Stem cylindrical, 1-1.5 cm diam., internodes 1.5-7 cm long. *Leaves* sessile or with a short, poorly defined petiole, blade thickly chartaceous, lanceolate to spathulate; rosette leaves 2-5 by 0.5 cm, climbing leaves c. 25 by 6 cm; apex acute, rarely acuminate, base attenuate, clasping the stem by 1/2 its circumference. Longitudinal nerves 3-5 on each side of the midrib, in the outer 1/3 or 1/2. Pennate nerves numerous, oblique, straight, nearly reaching the margin. *Lower Pitchers* obliquely urceolate, semicircular on dorsal side, almost flat ventrally, to 10 by 9 cm, with two fringed wings to 1.5 cm broad,

Figure 3: (A) A typical dense cluster of lower pitchers of *Nepenthes ampullaria*. (B) Colorful lower pitchers growing amongst leaf litter and other canopy debris. (C) An all red form. (D) Occasionally tri-color forms exist. Plants in photos A, B, C are growing in Gunung Mulu National Park, Borneo; photo D plant is growing at Kutching, Borneo. Photos taken by Richard Nunn.

the fringe elements 0.5-1 cm long, 0.2 mm apart; mouth oval, almost horizontal, straight; peristome flattened, to 1.5 cm wide, and sloping steeply inwards; lid narrowly oblanceolate, to 4 by 1.5 cm, apex rounded, base cuneate, lower surface lacking appendages, nectar glands extremely sparse,

Figure 4: (A) *Nepenthes ampullaria* occurs at higher elevations in New Guinea. These lower pitchers are growing at 530 m asl on Mt. Angemuk. Photo taken by Alastair Robinson. (B) A rare upper pitcher photographed at Sibolga, Sumatra. Photo taken by Richard Nunn.

usually 6-12, sometimes absent, orbicular, broadly bordered, 0.4-0.5 mm diam., central pore c. 0.1 mm diam.; spur simple or branched, up to c. 10 mm long. *Upper Pitchers* generally not developed, rudimentary, broadly infundibuliform, c 2 by 2 cm. *Male inflorescence* a panicle to 40 by 4-5 cm; peduncle 2.5 cm long, 3 mm diam. At base; partial peduncle 8-12(-50) cm long, fasciculate at apex, (1-)3-6(-10)-flowered; bracts foliose, spathulate, 12-14 by 4-5 mm, inserted 0-2 mm from base of partial peduncles; pedicels 7-8 mm long; tepals broadly elliptic, 4-5 by 3-5 mm, androphore 3-5 mm long; anther head 2 by 1.5 mm. *Indumentum* densely velvety in young parts, under leaf blades, especially margins, on young pitchers and on the inflorescence; hairs red or brown, mostly simple, 0.3 mm long. *Colour* of pitchers usually green, deeply flecked with maroon, rarely entirely red, sometimes almost whitish yellow, with pale pink flecks, likewise the leaves of these pitchers may be a pale yellow-pink if buried beneath leaf litter; tepals green to yellow; indumentum deep red.

Distribution and Ecology

One of the most widespread *Nepenthes* species, *N. ampullaria* is found in Borneo, the Maluku Islands, New Guinea, Peninsular Malaysia, Singapore, Sumatra, and Thailand. It has also been recorded from many smaller islands in the region. *Nepenthes ampullaria* generally grows in damp, shady forest from sea-level to 2100 m.

In Borneo, it occurs at elevations of 0 to 500 m on relatively flat terrain in *kerangas* forest, peat swamp forest, and degraded swamp forest (Clarke 1997).

In Sumatra and Peninsular Malaysia, it grows from sea-level to 1100 m elevation on flat terrain in heath forest, *padang*, peat swamp forest, and degraded swamp forest (Clarke 2001).

Populations found above 1700 m are restricted to New Guinea (McPherson 2009), where this species favors *Araucaria* forests, open microphyllous vegetation and swamp grassland (Jebb & Cheek 1997).

Natural Hybrids

Nepenthes ampullaria readily hybridizes with other lowland *Nepenthes* species with which it grows. The following species have been recorded as hybridizing with *N. ampullaria*: *N. albomarginata*, *N. bicalcarata*, *N. eustachya*, *N. gracilis, N. hemsleyana, N. hisuta, N. mirabilis, N. neoguineensis, N. rafflesiana, N. reinwardtiana, N. spathulata*, and *N. tobaica*. Hybrids with *N. gracilis* and *N. rafflesiana* were for a long time thought to be distinct species and were described and published as *N. trichocarpa* and *N. hookeriana*, respectively (Fig. 5).

Sources of Nutrients

Clarke (2001) suggests that *Nepenthes ampullaria* has developed strategies for obtaining sources of nitrogen other than from insects. This species is unusual in that it has evolved growing in shade beneath the forest canopy, where it receives a constant stream of debris, including twigs, dead leaves and flowers, and scat from above. Moran *et al*. (2003) estimate that *N. ampullaria* plants growing under the forest canopy derive 35.7% (±0.1%) of their foliar nitrogen from leaf litter. The author has observed this first hand at Kent Ridge in Singapore and Gunung Murud National Park, where populations of *N. ampullaria* are covered by a layer of detritus from the canopy above, often with just the pitcher mouth visible.

Figure 5: A natural hybrid between *Nepenthes ampullaria* and *N. rafflesiana*, *N* × *hookeriana* growing at Kent Ridge, Singapore. Photo taken by Richard Nunn.

Clarke (2001) points out that *Nepenthes ampullaria* has developed several unique adaptations as a result of evolving to consume canopy debris.

1. The pitcher lid is vestigial and reflexed away from the pitcher mouth, allowing debris to fall directly into the pitcher.
2. Nectar glands, an important component in prey attraction, are rare or absent from the pitcher lid.
3. In terrestrial pitchers, the glandular region extends almost to the peristome, so that there is little or no conductive waxy zone.
4. *Nepenthes ampullaria* pitchers lack "lunate" cells, the modified stomatal guard cells, which may deny prey a foothold in the pitcher (Lloyd 1942).
5. The plant's deployment of pitchers is unusual for the genus, often forming a "carpet" of pitchers covering the substrate, hence maximizing the area to capture falling debris.
6. The pitchers of *N. ampullaria* are relatively long-lived (remaining functional on average for 6 months), as a result of a relatively slower accumulation of nutrients.

Infauna

Pitcher plants not only utilize insects for nutrients, they also create their own ecosystem that supports other creatures. Phillips *et al.* (2008) record that several infaunal species have been recorded from the pitchers of *N. ampullaria*. Most notably one of the smallest known species of Old World frog, *Microhyla nepenthicola*, and the crab spider, *Misumenops nepenthicola*.

Conservation Status

Based on IUCN criteria *Nepenthes ampullaria* is rated least concern, due to its widespread distribution, also many populations are found in protected National Parks. Despite this, it is worth noting that in Peninsular Malaysia, Borneo, and Indonesia in particular, lowland forest is being cleared at an alarming rate to make way for real estate development, palm oil plantations, and other commercial crops.

Cultivation

Nepenthes grow in a wide range of habitats and ecosystems, *Nepenthes ampullaria* is considered a lowland species and although found above 500 m in some locations, predominantly grows between 0-500 m in tropical areas. What follows are basic guidelines only because every grower will have different variations on these themes that suit their individual conditions. If one is lucky enough to live in lowland tropical areas, *Nepenthes ampullaria* can be grown successfully outdoors in bright indirect light. The author grew many fine specimens on his balcony in Singapore over a 3-year period.

Light: This input is one of the most important in producing optimal pitcher size and coloration. As a guide, a bright position with high indirect light is best, although *Nepenthes ampullaria* do tend to grow in more shade than other species. If plants are grown under shade cloth, a level from 50% up to about 80% produces good results. The length of the daylight hours in their natural habitat is generally around 12-13 hours.

Moisture: *Nepenthes* like to be kept moist and *N. ampullaria* is no exception. Misting for a few minutes several times a day with good quality water and hand watering once every few days is enough.

Humidity: In a greenhouse, humidity around the plants is usually maintained to an acceptable level by their moist potting medium with the plants growing well with the fluctuating humidity levels that normally occur during the day. These levels usually range from 50-70% during the day and up to 100% at night. While plants growing in an outside environment will experience lower humidity levels than this, as long as the potting media is kept moist, the plants will be happy.

Temperature: This is probably the most important variable for successful growth of this species. In lowland tropical areas, the temperature range is remarkably stable, with daytime temperatures around 30°C and night rarely dropping below 24°C.

Media: This is a controversial topic as every grower will have their own special combination and swear by its effectiveness. A mix of quality orchid bark and long fiber *Sphagnum*, with some coarse perlite has proven very successful.

Nutrients: Insects are the best source of nutrients, however in cultivation a dilute mix of orchid fertilizer every few weeks is beneficial.

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An informal population report and observation of phenotypic variance and habitat of the Alabama Canebrake Pitcher Plant *Sarracenia alabamensis* Case & R.B. Case subsp. *alabamensis* (*Sarraceniaceae*)

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Abstract: Varying phenotypic traits of *Sarracenia alabamensis* Case & R.B. Case subsp. *alabamensis* (*Sarraceniaceae*), the Alabama Canebrake Pitcher Plant, were observed across its entire range. Listed under the U.S. Endangered Species Act, this rare, endemic species is currently limited to two counties across central Alabama. There is an undocumented phenotypic variability concerning pigmentation in five populations of *Sarracenia alabamensis* subsp. *alabamensis* across central Alabama. There appears to be higher levels of pigmentation in <5% of plants, characterized by a bilateral, interior ventral patch of anthocyanin pigmentation, terminating at the peristome and pitcher neck. Areolate and excess yellow coloration characteristics in these five populations, as well as net population status are reviewed and discussed.

Introduction

There is a total of five locations in two counties across central Alabama discussed in this report (Fig. 1), all visited within fall of 2016. Four visits occurred in the fall of 2017. *Sarracenia alabamensis* exhibits three main stages of growth during the active growing season. Beginning in mid to late April, the pitcher plants begin to bloom, producing multiple flowers per rhizomal growth point. Shortly after bloom, the first set of carnivorous leaves emerge, characterized by an enlarged ala, a perpendicular leaf "sail" on the anterior outside face of the pitcher tube. This enlarged ala, coinciding with significantly narrower pitcher tube diameters, results in spring growth being very floppy in nature. Later in the summer, from early June to mid July, *S. alabamensis* develops sturdier pitchers, displaying characteristics of typical individuals. Typical characteristics include yellowish-green coloration, fine pubescence, and maroon veining on the inside of the pitcher tube throat and lower operculum. A final growth stage is observed in *S. alabamensis* in the early fall months of September and October. The pitchers produced in this stage are the sturdiest, showiest, and most variative pitchers produced out of the three yearly growth stages. These are characterized by the same yellowish-green color, increased pubescence, areolate markings, and fine maroon veining on both the external and internal pitcher surfaces (Case & Case 1974; Harper 1922). *Sarracenia alabamensis* reproduces both sexually and vegetatively, with large genetically identical genets resulting from extensive vegetative reproduction

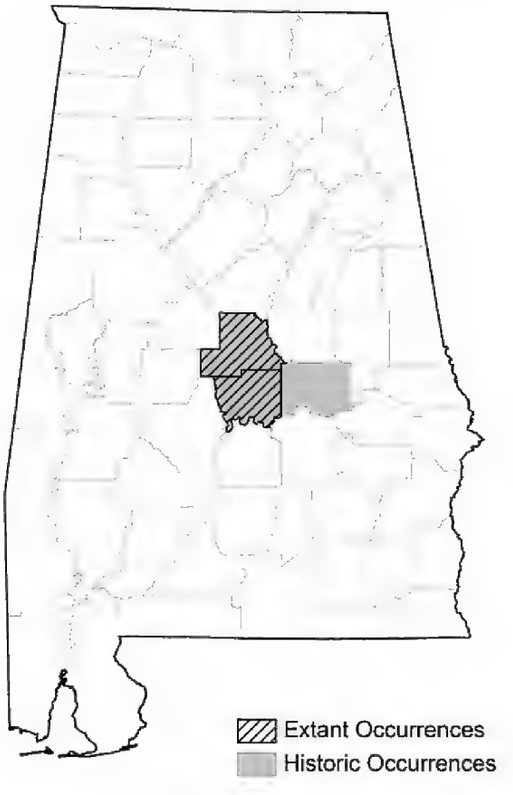

Figure 1: Known range of *Sarracenia alabamensis* subsp. *alabamensis* (U.S. Fish and Wildlife Service 2012).

over time via rhizomal growth point division. These genets are classified by size, being referred to clumps in various instances. Large and very large genets are observed at almost all sites below, classified by an abundance of pitcher leaves, ranging from 75-150 in large genets, and 150-200+ leaves in very large genets. These clumps exhibit identical phenotypes and are therefore presumed to be genetically identical ramets in each respective clump (Murphy & Boyd 1999).

Visits to all sites occurred during this fall growth time frame to ensure continuity in documenting the plants and their unique characteristics. Observations concerning blooms are included in some of the sites discussed below, but spring and early summer pitcher characteristics and observations are omitted. This is, in part, due to lack of notes, as well as an overall similarity in pitchers and phyllodes between all plants in this growth stage. Mature, adult pitchers and individuals are primarily reviewed. Seedling and juvenile pitchers originating from young plants tend to periodically show higher overall pigmentation and anthocyanin content, and therefore do not serve as reliable data for observations.

Description, Phenotype, and Varietal Observations (Table 1)

Site I.

Site I is managed and burned periodically by an Alabama conservation agency. Site I is alongside a seepage slope in Autauga County, Alabama, with approximately 200 individual plants (Fig. 2). An additional relict site occurs adjacent to this main population on a similar seepage slope, with large amounts of *Sphagnum* constituting the primary soil associate; there are approximately 15 large clumps found here. These large plants had an average of 75 leaves per clump. There were many seedlings observed at the main population, suggesting a very high seedling recruitment. A fair amount of woody shrub associates is found at both the main population and relict population, suggesting periodic burns are extremely necessary for the site's continued success. Resulting from the isolation of this site from human development, as well as being permanently protected by a conservation agency, this site does not have any immediate human impact concerns, quintessential to site viability.

The foremost and largest population at this location exhibits a whole array of variations. There is a large number of plants that display the well-known faint areoles in late summer pitchers (Case & Case 1974). This areolate characteristic is defined in *S. alabamensis* to be faint, thinner patches, limited to the top third of the pitcher, that allow light to enter the pitcher. This is seen in *Sarracenia*

Table 1. *Sarracenia alabamensis* phenotype population data.

Population	Approximate number of individuals	Plants with throat patch present	Plants with increased pigmentation (coppery-red)	Plants with increased pigmentation (ornate venation)	Plants with lighter flower color variance
Site I	200	0	0	*20	4
Site II	75	0	0	*30	N/A
Site III	25	0	3	*20	N/A
Site IV	3	-	-	-	N/A
Site V	100	6	4	*30	N/A

(*) an approximate number was recorded.
(N/A) visits did not occur during flowering.
(-) data were not available due to an absence of pitchers.

Figure 2: Site I habitat and typical *Sarracenia alabamensis*.

leucophylla Raf. and *Sarracenia minor* Walt.; in *S. alabamensis* this quality is far diminished in comparison to the other two *Sarracenia* species. Additionally, plants at this location display a wide range of size in late summer pitchers; those located in the right-hand half of the population when facing north has an overall larger size. This however, could be seasonal variance, with different seasons presumably containing individuals with larger pitchers from other areas of the population, as well as plant age. Some individuals exhibit both qualities more so than others, suggesting genetic diversity.

Specific individuals also show a variety of yellow coloration, with approximately 20% displaying significant and dense yellow pigmentation on the pitchers, as characterized by an intense, almost overlaid fluorescent green-yellow color. There appears to be uniform continuity concerning the pigmentation of the internal pitcher structure, with sparse, dark maroon veining extending from the pitcher opening, to operculum, and down the pitcher tube. Pubescence is a defined characteristic of *S. alabamensis*, with small hairs (similar to peach fuzz) covering the exterior pitcher tube; this is especially prominent on the upper two-thirds of the pitcher tube (Case & Case 1974). Pitcher pubescence was very common at this site, occurring in over half of the plants.

When visiting this site in May 2017, around peak bloom time, most individuals were observed to have flowers with deep, maroon petals. However, approximately 5% of the plants here exhibited significantly lighter petal coloration–almost rose red–noticeably lighter in pigmentation when compared to the rest of the population. These individuals with such characteristics additionally had a larger yellow petal margin surrounding the edges of the petal.

Site II.

Site II in Autauga County, Alabama, is a similar seepage type environment (Fig. 3). The landowner suggests that the primary water source for this site is an underground spring; this water source al-

Figure 3: Largest contiguous population of *Sarracenia alabamensis* at Site II; population density is high here.

lows the site to have a very even hydrology with consistent and above average soil moisture, almost muck-like. The population here appears to be composed of two extremely dense groupings, divided by about 20 m. Population density is 3-6 large genets per m^2. The largest of the groupings contains an estimated 75 individuals, with the smaller containing approximately 25. Many seedlings in their second and third years of growth were seen as well. The extremely large individual plants that grow here, with 100+ leaves per plant, suggest genetic individual genets (Murphy & Boyd 1999).

This healthy population faces immediate challenges concerning human impact however. Nearby gravel mining, as well as tractor and vehicle disturbances next to the main contiguous population can potentially alter the site hydrology thereby harming the population. This gravel mining has created large pools of water across the adjacent land, some extremely close to the plants. However, the current landowner appears to be extremely enthusiastic and proud of the naturally occurring plants on his property and has taken measures to ensure protection of the site through conservation easements and cooperative management. As a result of past and potential human impact, this site is in need of further protection to ensure site viability.

Site II contains a large number of *S. alabamensis*, characterized by the extremely dense populations. The estimated 75 individuals exhibited large genet qualities, with anywhere from 50 to 125 leaves being counted on each plant. To a lesser extent, there was variability in plants, but not to the degree as seen at other sites. An overall uniformity in areolate pitchers was observed, with an estimated 70% of individuals exhibiting this characteristic. Yellow pitcher and veining pigmentation was uniform as well; outliers were observed however. A handful of ornate individuals, with increased reticulation on both interior and exterior pitcher surfaces, as well as plants with lesser pigmentation, with very little reticulated veins, were present. Such qualities being uniform in distribution at this site suggest slightly lower genetic population diversity in comparison with other

Figure 4: Early summer pitcher growth on a red genet "clump" at Site III.

populations. However, there is healthy seedling recruitment at this locale, notably in disturbed soil areas, such as tracks made by vehicles in the wet soil.

Conversely, the overall late summer pitcher size was interestingly larger than previously documented sites. Measured pitcher tube length was between 30 cm and 42 cm, with the larger individuals displaying areolate characteristics more so than not. At this population, areolates appear to occur in the plants having larger pitchers in late summer. Additionally, pubescent pitchers were extremely common and uniform at this locale, with an overall majority of plants being pubescent.

Site III.

A streamside bog houses the Canebrake Pitcher Plants at Site III, growing adjacent to a nearby wetland and creek (Fig. 4). The ground and substrate appear to be consistently moist, with a hydrology gradient present. The plants here grow in a "band" in this gradient, with approximately 25 individuals present. This site's plants exhibit clumping behavior, characterized by numerous rhizomal growth points arranged in a circular pattern. These genets can have plants growing in a solid, contiguous clump, or in older individuals, have plants in a ring, with old rhizomal material not being present in the center (Murphy & Boyd 1999). Genets at this site have anywhere from 75 to 200+ leaves per clump. Concerning the population's reproduction, there were zero seedlings observed at this site, searched for on multiple occasions.

The landowner said in 2016 that the site had not had a controlled burn in over five years. A controlled burn was conducted in early 2017, and by the fall of 2017, individual clump health at the site appeared to be in good condition due to the lack of woody shrub undergrowth. In fall 2017, there appeared to be a high frequency of deer and or other animal damage to the plants' increased seed pod and flower stalk production. Additionally, with this site being within 100 m of the landowner's residence, as well as less than 30 m from a livestock pasture, outlook on site viability appears to be

moderate. The presence of a beaver dam has altered the creek hydrology upstream and although not impacting the population directly, has created yet another challenge concerning this site. However, the habitat is extremely healthy, and although challenging, could be a viable site with continued periodic burning and management.

Located on the margin of a healthy wetland ecosystem, this population is situated on a hydrologic gradient. On the periphery of a wetland habitat with numerous aquatic plants, this area is in a transition zone from extremely wet to moderately dry. There are both woody shrubs and bog associate plants present. Plants here appear to grow in a wetness band of about 15 m. All visits to this site have revealed consistent soil moisture, with visible water pools in areas on the edge of this gradient. The Canebrake Pitcher Plants at this location display a large margin of phenotypic variance, with a great variety of pitcher appearances observed. The well-known and defined areolate characteristic, common to all *S. alabamensis*, is found here on approximately 50% of the individuals, with a few clumps displaying extremely prominent areoles on late summer pitcher tubes. This is limited to the top third of the tube, terminating just before the operculum (Case & Case 1974). Interestingly, pitcher pubescence was not very common at this locale, with approximately 30% of genets possessing pubescence.

However, the most interesting feature that the Canebrake Pitcher Plants consistently exhibit at this site is the presence of high amounts of (red) anthocyanin pigmentation in a handful of individuals. Three mature clumps were found to exhibit pigmentation, with one displaying very coppery-red pigmentation, and two displaying an overall bronze coloration, darker than typical individuals, with an infused copper color extending up the exterior surface tube and the operculum. Note: during both an early summer visit and late summer visit, the clumps exhibited this reddish coloration on all pitchers, not limited to a select number of pitchers. Young and old pitchers had a similar degree of pigmentation. Therefore, this feature is concluded to have genetic influence and not environmental factors.

Moreover, each genet at Site III appears to possess individually unique characteristics, suggesting that each is composed of between one and three genetically unique individuals. The large variety of traits in each individual grouping of *S. alabamensis* at this site therefore imply significant genetic diversity.

Site IV.

Site IV in Chilton County, Alabama, is an extremely small site, with an estimated three individuals present in 2017 (Fig. 5). The site appears to be a stream-associated wetland environment, with a drainage stream and horse pasture in close proximity to the plants. The human impact on this site is extremely high, creating more of a novelty, relict site than anything. A road is very close to the location of the plants, less than 30 m away. Horses and livestock have grazed on the edge of the site, albeit protected by a simple wooden fence. Factoring these impacts in, as well as a large presence of dense grasses and woody shrubs, further continuance of this population does not appear to be likely.

This critically threatened site contains approximately three individual *S. alabamensis* plants, all observed without active pitchers at the time of visit. The only leaves present on the plants were non-carnivorous phyllodia (Fig. 5). However, an interesting characteristic of the few plants found here is that the phyllodia are analogous to that of *Sarracenia flava* L. or *Sarracenia leucophylla*. These phyllodes are characterized by being erect, sturdy, and wide, approximately 3.5 to 4 cm measured at the widest point on each phyllode; this is significant because typical phyllodia are 2.5 to 3 cm wide. Additionally, the phyllode length was greater, being 20 to 25 cm, versus typical lengths of 13 to 17 cm. Typical individuals have less sturdy phyllodia. Viability of this site appears to be novel, due to

Figure 5: Site IV phyllodia of *Sarracenia alabamensis*.

the extremely developed surrounding landscape, significant horse and livestock influence, as well as severe habitat fragmentation.

Site V.

Site V is located in Autauga County, Alabama. This site is estimated to be at the presumed southernmost edge of the natural *S. alabamensis* range. The site features a seepage slope having a sharp topographic incline with consistent soil moisture. An estimated 100 individual plants are located on this steep slope. An extremely high amount of seedling recruitment was observed, with dense numbers of seedlings (approximately 10 per m^2) located in places not inhabited by dense undergrowth plants. Human impact for this site is minimal, especially considering its relatively recent discovery. It is isolated and remote; therefore, disturbed hydrology and other human impacts are not prevalent at this site. Site viability appears to be extremely positive.

At this locale, there is a fair amount of variance in pitcher diversity, with typical and ornate individuals observed (Fig. 6). These ornate individuals are classified by greater pigmentation and reticulate venation located in the interior of the pitcher tube and operculum.

In addition to ornate individuals, a small number of individuals, an estimated 10% at this site, exhibited the similar red-copper coloration of those at Site III. These pitchers contained the pigmentation on all outer surfaces of the pitcher tube, extending well onto the operculum and terminating at the tip. The peristome surface was a light yellow, as was the pitcher opening and neck. On all coppery individuals, the pitcher neck exhibited the same standard maroon throat venation. Note: these coppery pitchers were both young and aged pitchers, estimated to range between less than

Figure 6: Extremely coppery-red pigmented *Sarracenia alabamensis* individual at Site V, with a typical individual growing in the center of the foreground genet.

a week to three or five weeks old at the time of visit. Young pitchers tend to display more coloration, decreasing with pitcher age. However, on these plants, this coloration does not fade with older leaves.

Moreover, a characteristic of this site is that on very few plants, there seems to be an extremely unique trait, not found at any of the other four sites mentioned above. A darker purple-maroon bilateral throat patch (Fig. 7) was seen on typical and copper individuals alike. This throat patch is located on the inside ventral surface of the pitcher opening, extending into the neck and around to the post-interior pitcher tube surface. The peristome on all of these individuals was a stan-

Figure 7: Extreme pigmentation of *Sarracenia alabamensis* with throat patch clearly visible. Plant in cultivation under the name "AL0002" from the ICPS 2001 *Sarracenia* Distribution Project. Photo by Michael Wang.

dard green color. These purple throat "patches" exhibited what appeared to be elevated nectar production, suggesting that this might have insect-attracting properties. Taking in the above factors into account, there appears to be a high amount of genetic diversity in this population, especially in light of the presence of this unique throat coloration.

Discussion

A purple-maroon throat patch is occasionally found on the ventral interior surface of the pitcher tube, terminating before the interior posterior pitcher tube surface and extending no more than past the peristome (Fig. 7). This patch exhibits what appears to be elevated nectar production in observed individuals and suggests insect-attracting properties. This throat patch appears to be extremely uncommon and is not observed in all naturally occurring populations of *S. alabamensis*. Plants from Autauga County, Alabama, appear to be more prone to possessing this throat patch. There is an additional known site having plants with this pigmentation, but this additional site is not included in this report because it was not visited.

Upon further research, Internet searches, speaking with various members of the conservation community, and seeing private collections, the presence of the throat patch seems to be significant. Birmingham Botanical Gardens (BBG) is in partnership with a private conservation alliance, which has allowed BBG to house a safeguarded population of *S. alabamensis*. These safeguarded plants reportedly originate from the unvisited population in Autauga County, mentioned above. Most individuals in this collection are approximately 5 to 7 years old and are considered vegetatively young but mature, indicated by a high amount of flower production. However, there was one individual of an estimated 40 that quite noticeably exhibited this prominent throat patch. This individual had five mature, fall growth pitchers, all exhibiting the throat patch pigmentation.

Michael Wang, a private *Sarracenia* collector in California, known for his cutting-edge cultivation skills and meticulous record keeping, obtained an individual *Sarracenia alabamensis* from the 2001 International Carnivorous Plant Society *Sarracenia* Distribution Project (Rice 2003), catalogued as "AL0002". This plant, although grown in ideal cultivation conditions, exhibits a very strong throat patch (Fig. 7). Taking this into account, this characteristic could be one that appears more frequently in optimal growing conditions, suggesting overall site health.

The throat patch appears to be a stable characteristic that remains over the growing season, especially in the larger early summer and early fall pitchers. Questions arise about the presence of this patch, such as its purpose, if it is a recently evolved quality, and whether it could suggest strong ancestral links to other species. Further studies of this throat pigmentation, as well as higher pigmentation in coppery individuals could shed light into their effects on predation and ability to attract insects. A prey study in which individuals are measured based on coloration, presence of throat patch, pubescence, and areolate qualities across the species domain is not only feasible but could offer valuable insight into the evolutionary significance of these properties. Moreover, the extremely low frequency at which the unique throat patch occurs in natural populations of *S. alabamensis* perhaps suggests a number of things. Recessive gene expression for the throat patch that is otherwise replaced by dominant "non throat patch" genes, ancestral and historic links to other species, as well as if effective in attracting prey more efficiently, a recently evolved characteristic of the species could very well be possibilities.

This throat patch, although not analogous to *Sarracenia alata* (Wood) Wood, shows a striking similarity to some individuals of this species, specifically *Sarracenia alata* var. *rubrioperculata* S.McPherson & D.E.Schnell. General similarity with *Sarracenia alata* var. *alata* is extremely no-

ticeable; to the untrained eye one might think they are the same species. Moreover, the larger fall pitcher production characteristics seen in *S. alabamensis* are similarly seen in a number of species: *Sarracenia leucophylla, Sarracenia alata,* and all members of the *Sarracenia rubra* Walt. complex (Case & Case 1967). With the range of *S. alata* being one relatively adjacent to that of *S. alabamensis*, perhaps the presence of the throat patch, coppery coloration (seen in *Sarracenia alata* var. *cuprea* S.McPherson & D.E.Schnell), and increased size in fall pitcher production suggests recent ancestral roots connecting *S. alabamensis* to other members of the *Sarracenia* genus. Additionally, *S. alabamensis* historically shared the same habitat with an Elmore County, Alabama, *Sarracenia oreophila* (Kearney) Wherry population (extirpated), suggesting that during its evolution, it could have very well shared habitat and therefore hybridized with other members of the genus (Harper 1922).

In conclusion, *Sarracenia alabamensis* subsp. *alabamensis* presents many unsolved characteristics and qualities that are of significant value. Unlike other members of the genus *Sarracenia*, *S. alabamensis* has not been subject to much research due to its critically endangered status. Further studies delving into its phylogenetics, pigmentation genes, significance of the unique traits in this species, and the function of such could reveal further factors involving *Sarracenia* evolution, population dynamics, and ultimately, the continuance of this amazingly unique but critically threatened species.

Additional Information

Noah Yawn is currently a Senior at Helena High School in Helena, Alabama, who aspires to further study conservation and environmental sciences in his collegiate endeavors. This informal report is based on of his casual experience in the field, as well as informed status in the realm of *Sarracenia* and other native aquatic and marginal wetland plants. Based on his notes taken in the field, this report aims to discuss these observations and provide relevant conservation organizations valuable insight and recent information pertaining to this species and its native habitat. He hopes this report serves as useful insight into the diverse but increasingly critical populations of *S. alabamensis*.

Access to these populations was given by various private landowners and conservation agencies. As an aspiring photographer and naturalist, the main purpose of his visits to these secure sites were to photograph and document *S. alabamensis* for private and conservation use; while at the sites, observations and notes were recorded alongside photographs. Due to the nature of these sites, as well as specific conservation provisions and efforts to preserve the species (U.S. Fish and Wildlife Service 1992, 2012), listed under the Endangered Species Act, specific location data and or information is not included in this report.

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Germination rate and longevity of seeds of *Aldrovanda vesiculosa* and *Utricularia vulgaris*

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Introduction

The ecological group of aquatic carnivorous plants includes monotypic *Aldrovanda vesiculosa* L. (Droseraceae) and around 60 species of *Utricularia* L. (Lentibulariaceae). Although the majority of aquatic carnivorous species are perennials and propagate mainly vegetatively by branching, shoot fragmentation and turions, the majority of them also set seeds (Taylor 1989; Cross 2012; Cross *et al.* 2016, 2018). While these modes of vegetative propagation in temperate species ensure the production of high plant biomass at sites during each season and turions also serve population overwintering (Adamec 1999a, 2011), functional seeds form a viable seed bank as a safety measure to overcome crucial habitat disturbances (mainly drought) leading to biomass extinction and are usually spread by water birds to colonize new potential distant sites (Santamaria 2002; Cross 2012; Cross *et al.* 2016, 2018).

Temperate native European and introduced North American populations of *Aldrovanda vesiculosa* flower relatively commonly under optimum habitat conditions (Front Cover) but their seed set is rare and limited (Adamec & Tichý 1997; Adamec 1999b; Cross 2012; Cross *et al.* 2015, 2016). *Aldrovanda* produces ovoid, rigid seeds 1.2-1.5 mm long with highly developed honeycomb-like exotesta and it is assumed that they are spread via water birds (Cross 2012; Cross *et al.* 2016, 2018). Older fragmentary pieces of knowledge on *Aldrovanda*'s seed set and germination features (see Cross 2012 and the references therein) have recently been complemented by Cross *et al.* (2016). For freshly collected seeds from SW Australia, the optimum temperature for germination was 25°C in light, while no germination was observed in darkness. Germination was also the best with ethylene and after 8 weeks of cold stratification (5°C) interrupted by an 8-week warm period at 25°C; control seeds were kept at 5°C in darkness. To estimate seed longevity, when fresh seeds in bags were buried in sediment 1 cm deep at a natural site for 6 months, only 20% of the seeds survived and after burial for 1 year, all seeds died. Thus, this result can be interpreted as rather limited seed longevity under natural conditions of bottom sediment which would prevent the existence of a seed bank. On the other hand, at a natural Hungarian site, population recruitment after a several-year break and lake drying out occurred (Adamec, unpubl. data), which confirms a functioning of seed bank for several (ca. 10) years. Moreover, seeds stored in a dry state reduced partly their germination rate after 1 month, but completely after 1 year. Similarly, freezing fresh seeds to -18°C for only 24 h reduced the germination rate by 10-45%, while freezing for 3 months completely inhibited germination (Cross *et al.* 2016). Physiological dormancy is stated for *Aldrovanda* seeds (Cross *et al.* 2018).

European populations of *Utricularia vulgaris* flower and set seeds prolifically (Taylor 1989). The seeds usually ripen in capsules above the surface but fall soon to water and sink to the bottom. The seeds ca. 0.6 mm large have a morpho-physiological dormancy (Holzbauerová 2015; Cross *et al.* 2018). Similar to *Aldrovanda*, *U. vulgaris* seeds germinate better at a higher temperature of 25°C and in light and break their dormancy after weeks of cold stratification, with ethylene, or

after a frost treatment (Holzbauerová 2015). Unlike *Aldrovanda*, seeds stored both under water or in dry state for 1-2 years germinated equally well. In *U. vulgaris*, a persistent seed bank exists. Gálová & Hájková (2014) found native seedlings of this species at a former fishpond site in S Moravia, Czech Republic, where the species was considered extinct for ca. 23 years. From organic bottom sediments dated between 70-100 years old, released *U. vulgaris* seeds germinated in light as soon as 6 days. Pieces of evidence thus indicate that the longevity of the *Aldrovanda* seed bank is very variable and much shorter than that of *U. vulgaris*. The aim of this study is to compare the survival and germination rate of *Aldrovanda* and *U. vulgaris* seeds exposed in nylon bags on top of a bottom sediment or slightly buried in it in a sand-pit pool in the Czech Republic for 11 months (cf. Cross *et al*. 2016).

Methods

The experiment was conducted in a ca. 250 m^2 shallow sand-pit pool within the complex of excavated sand-pit Cep I near Suchdol nad Lužnicí in S Bohemia, Czech Republic (48°55'08.5"N, 14°53'3.1"E, 450 m a.s.l., see Fig. 1). The pool is about 15 years old, about 50-60 cm deep and the bottom sediment around 5-10 cm deep consists of fine clayish acidic sand mixed with organic substrate from decomposed plant litter. The pool is supplied with rainwater coming from a near terrace and its quite transparent water is extremely soft (electrical conductivity between 22-187 µS cm^{-1},

Figure 1: Shallow pool in a sand-pit Cep I near Suchdol nad Lužnicí in S Bohemia, Czech Republic, is inhabited by introduced *Aldrovanda vesiculosa* and *Utricularia bremii*. The seed exposure experiment was conducted near the left shore.

usually only 30-50 µS cm^{-1}), slightly humic (dystrophic) and oligotrophic; pH ca. 6-7 (for details, see Adamec 2009; Cross *et al.* 2016). Native plant dominants in the pool were *Eleocharis palustris*, *E. acicularis*, *Potamogeton natans*, *Juncus bulbosus*, and *J. effusus*. Introduced dominants were *Utricularia bremii*, *Luronium natans*, and *Potamogeton alpinus* (Adamec & Kučerová 2013). Since 2009, also Hungarian red plants of *Aldrovanda* have been growing in the pool. In 2013 and 2014, its population contained at least 5000 plants and in both summer seasons each, at least 1000 plants flowered here and hundreds of ripe capsules were collected (Cross *et al.* 2016). In the 2015 season, its population was drastically decimated by the unknown (perhaps fungal) '*Aldrovanda* disease' (see Adamec 2007) and only dozens of plants have survived up to now.

Ripe seeds of *Aldrovanda* were collected from this pool in summer 2014 and the clean seeds were stored in humic water in a refrigerator for about one year before the experiment. Ripe seeds of *U. vulgaris* were freshly collected from an outdoor culture in the Institute of Botany at Třeboň in summer 2015 and stored in dry state in a refrigerator. Twenty *Aldrovanda* seeds were checked for mechanical stiffness and 40 *U. vulgaris* seeds were put into each of 10 fine nylon bags of 3.5 × 3.5 cm (mesh size 150 µm) and the tagged bags with seeds were closed with a flame. Five bags with the seeds were connected with each other using a nylon line to form a star (Fig. 2). On 1 Sep. 2015, five of the bags were placed on top soil in the pool ca. 40 cm deep near the shore, while the other five were buried 1-2 cm in the soft sediment about 25 cm nearby. Both sets of bags were fixed by a wooden stick. The seeds in the bags were exposed in the pool over winter for 11 months until 30 Jul. 2016. To estimate oxidation-reduction conditions in the exact place of seed exposure of both

Figure 2: Fine nylon bags with *Aldrovanda* and *U. vulgaris* seeds after they were taken out of the shallow sediment after the 11-month exposure.

variants, the electrical redox potential was measured on the top soil and 1-2 cm deep in the sediment near the exposed bags on 9 Jul. 2016. Platinum and Ag/AgCl reference electrode and a portable digital mV meter were used for the measurements. Ten parallel redox potential measurements were conducted for each variant and the potential of the reference electrode (218 mV) was subtracted from the measured value.

On 30 July 2016, the seed exposure was terminated, the bags were washed by tap water, and the seeds taken out from the bags. Within each bag, just germinating and non-germinating seeds were counted; the remaining seeds were considered damaged as no intact seed could escape from the bags. The remaining clean seeds from each bag were put in a small translucent plastic box in 20 ml of filtered humic water to germinate. All 10 plastic boxes were put into a 3.5-l miniaquarium filled with tap water which floated in an outdoor 2 m^2 plastic container. The seeds in humic water were thus naturally lit and exposed near the water surface at temperatures similar to those in natural habitats. The boxes with the seeds were alternatively exposed outdoors or at ca. 3.5°C in darkness in a refrigerator to break seed dormancy (*sensu* Holzbauerová 2015; Cross *et al.* 2016). After 4 days of outdoor exposure, they were put into a refrigerator on 3 Aug. 2016 for 3 days until 6 Aug. 2016. Then, after 6 days of outdoor exposure on 12 Aug. 2016, they were put into a refrigerator for 10 days until 22 Aug. 2016. After 9 days outdoors, they were put into a refrigerator on 31 Aug. 2016 for 3 days. On 3 Sep. 2016, they were exposed outdoors for 11 days until 14 Sep. 2016. After 5 days in a refrigerator, on 19 Sep. 2016, they were exposed outdoors for 29 days until 18 Oct. 2016. The remaining seeds then overwintered in a refrigerator for 9 months until 24 Jul. 2017. After another 13-day outdoor exposure, the boxes were put in a refrigerator on 6 Aug. 2017 for 8 days until 14 Aug. 2017. They were then exposed outdoors until 4 Sep. 2017 for 21 days and then put into a refrigerator until 14 Sep. 2017 for 10 days. They were then exposed outdoors until 2 Oct. 2017 for 18 days. At the end of each outdoor exposure, germination of seeds was scored and germinated seeds were removed from the boxes. The cumulative germination rate within each box (bag) is expressed in % of the original seed count. Means ± 1 SE intervals are shown for 5 bags within each variant but the data clearly followed a non-normal distribution.

Results and Discussion

The redox potential on the top soil was -209.8 ± 8.7 mV, while that 1-2 cm deep in the bottom was -376.4 ± 6.6 mV, indicating an anoxic zone in the sediment. Between 3-7% of seeds were damaged and their testa was ruptured at the conclusion of 11 months of storage in sediment or top soil (Table 1). The difference between both treatments is not marked. The first seeds started rarely germinating only after two short cold/warm stratification treatments. However, the germination was markedly stimulated after the next 11-month cold stratification in a refrigerator as a result of which about 19% of the seeds germinated in light outdoors (Fig. 3). A further germination was very low. Unlike these results, fresh *Aldrovanda* seeds did not survive a one-year period of shallow burial in a bottom sediment at an Australian site (Cross *et al.* 2016).

Only 3-5% of *U. vulgaris* seeds were damaged after the field exposure in both variants (Table 1). Generally, the germination pattern was very similar to that in *Aldrovanda*. First *U. vulgaris* seeds germinated as early as at the end of the field exposure in the bags in the top soil variant. Germination was very low even after two short cold/warm stratification treatments. Seed dormancy was markedly broken after the next 11-month cold stratification and about 37% seeds germinated in light outdoors afterwards (Fig. 3). Only the next 2-3% of the seeds germinated by the end of the summer season.

Table 1. Results of the cumulative germination rate of *Aldrovanda vesiculosa* (AV) and *Utricularia vulgaris* (UV) seeds during the 2016 and 2017 seasons. On 1 Sep. 2015, five parallel nylon bags each with 20 seeds of *A. vesiculosa* and 40 seeds of *U. vulgaris* were placed on the top of a loose sediment (variant T) and another five bags were buried 1-2 cm deep in the sediment of a shallow sand-pit pool (variant B; see Fig. 1) for 11 months until 30 Jul. 2016. Damaged and germinated seeds were evaluated (in % of all seeds for each bag, means ± SE intervals shown, n=5). Seeds of both species were allowed to germinate in natural light in humic water in translucent vials. Light exposure was interrupted by periods of dark cold treatment at 3-4°C (see the text).

	30 Jul. 2016		12 Aug. 2016	31 Aug. 2016	31 Jul. 2017	4 Sep. 2017	2 Oct. 2017
Species	Damage	Cumulative germination rate (%)					
AV-T	7.0 ± 3.8	0	0	0.5 ± 0.5	19.0 ± 4.3	20.0 ± 4.7	20.0 ± 4.7
AV-B	3.0 ± 2.0	0	0	0.5 ± 0.5	20.0 ± 5.2	21.0 ± 5.6	21.0 ± 5.6
UV-T	5.0 ± 1.6	1.0 ± 1.0	1.5 ± 1.0	2.0 ± 0.9	39.5 ± 5.5	41.0 ± 5.7	41.5 ± 6.0
UV-B	3.0 ± 2.4	0	0.5 ± 0.5	1.0 ± 1.0	37.5 ± 5.3	39.5 ± 4.4	40.5 ± 5.3

Figure 3: Germinating seeds of *Aldrovanda* (top) and *U. vulgaris* from the experiment. The diameter of the plastic lid is 25 mm. Photos by Lubomír Adamec.

Conclusions

The seasonal seed exposure on the top soil or 1-2 cm deep in the sediment had no influence on seed longevity and subsequent germination rate in *Aldrovanda* and *U. vulgaris* seeds. This indicates that a deeper anoxia is not harmful for these seeds. For both species, the germination rate in single bags was highly variable. The longevity of *Aldrovanda* seeds under natural conditions in water can be very variable and be shorter than one year but also longer than 2-3 years. The factors which decide seed longevity might be the population origin (temperate *vs*. subtropical), plant batch, or natural conditions on the bottom or in the sediment.

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Big Lagoon Bog

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The Big Lagoon Bog is an inconspicuous 1.3 ha peatland in coastal northwestern California (Figs. 1&2). A reason the bog is of interest to me is that it contains both *Sphagnum* and *Drosera rotundifolia*—neither are rare by any stretch of the imagination. What makes this location special is that the bog is isolated with the nearest *Drosera rotundifolia* neighbors about 80 km north and 200 km south. Peat bogs are rare at low elevations along the coast in California. In contrast, the *Darlingtonia* bogs in the Klamath region are perennial wet, nutrient poor, ultramafic outcrops with little or no *Sphagnum*.

The Big Lagoon Bog lies 3 m above sea level and is within 300 m of the Pacific Ocean coastline. The bog drains into Big Lagoon, a 590-ha brackish embayment separated from the ocean by a narrow 6 km long sand bar. Winter rainfall raises the water level in the lagoon several meters above sea level where hydrostatic pressure and high surf breaches the sand bar allowing the lagoon to drain into the ocean and then receive tidal inflow until wave action reforms the bar.

Big Lagoon Bog is one of the few peatlands in California that have received floristic study (Leppig 2002; Smith 2014). Leppig (2002) found a total of 77 vascular taxa at the bog of which 5 taxa were rare (*Carex huxbaumii*, *C. viridula*, *Lathyrus palustris*, *Lycopodiella inundata*, and *Lycopus uniflora*) and 13 alien taxa. The high proportion of alien taxa is due to the area having been logged and grazed, with adjacent homes, a county park, and a nearby campground.

The area was originally occupied by the Yurok people, but when European settlers arrived in the 1870s, the forests were logged and the land converted to farming and grazing. In the late 1920s

Figure 1: An overview of the Big Lagoon area and the Big Lagoon Bog (inset right). Image from Google Earth.

Figure 2: Big Lagoon Bog overview (left) and close-up (right).

vacation cabins were built immediately west of the bog. The surrounding forest now consists of 90-year-old even-aged Sitka spruce (*Picea sitchensis*). In 1973, the bog became part of the Big Lagoon County Park when the land was purchased by Humboldt County. The Big Lagoon Elementary School is 300 m upstream of the bog and the small community of Big Lagoon (population 78) is located to the immediate southwest.

The climate is cool Mediterranean with a narrow temperature range. In July, the average high temperature is 18°C and the low is 11°C, and in January the average high is 13°C and the low 5°C. Freezing temperatures are uncommon. Average annual precipitation is 172 cm, 90% of which falls between October and April. Fog is prevalent. In 1939, the U.S. Navy established an airport 20 km south of the bog, only to discover it to be located in the third foggiest weather in the world (Shettle 1997). This foggy area is the result of an east-west offshore submerged ridge that causes upwelling of the cold Alaskan current. The contact between the cold ocean water and relatively warmer air produces fog. The old Navy airport is now Humboldt County's commercial airport where weather delays are not unusual.

The offshore submerged ridge is at the Mendocino Triple Junction, the point where the Gorda plate, the North American plate, and the Pacific plate meet, linking convergence of the northern Cascadia subduction zone and the southern San Andreas Fault system, making this one of the most seismically active areas in the world. The Cascadia subduction zone is a 1000 km undersea fault that runs from British Columbia down through Washington and Oregon and terminating at the Triple Junction 30 km off the northern California coast.

The oral history of tribes living along the Pacific Northwest coast consistently contain stories and myths of great tsunamis covering the land – including Big Lagoon. For example, a myth recorded over a century ago by ethnographer A.L. Kroeber, Ann of Espell of the Yurok tribe recounted: "Thunder wants people to eat. He thinks they will if prairies are made into ocean. He asks Earthquake for help. Earthquake runs about, land sinks, and prairies become ocean teaming with salmon, seals, and whales" (Kroeber 1976; Carver 1998). Until the early 1980s, the Cascadia region was thought to be incapable of producing earthquakes greater than magnitude 7.5 and that any tsunami striking the coast would have originated from afar (Atwater *et al.* 2005).

There is no written record by people living along the Pacific coast before about 1800. However, Japanese researchers found several tsunami records in Japan from AD 1700 with no indication of a local cause (Satake *et al.* 1996; Atwater *et al.* 2005). Based on calculated travel time of the tsunami from North America to Japan, the last major Cascadia subduction earthquake was determined to have occurred at 9 p.m. local time on 26 January 1700. From the tsunami heights, the earthquake

is estimated to have been magnitude 9, one of the world's largest, and ruptured the entire 1000 km length of the Cascadia subduction zone. The resulting tsunami is estimated to have been 15-20 m high near Big Lagoon (Rice 2016). Research has now estimated that the Cascadia fault has produced at least seven magnitude 9 or greater megathrust earthquakes and associated tsunamis in the past 3500 years, a frequency that indicates a return time of 300 to 600 years (Atwater *et al.* 2005).

In 1988, John Parker studied sedimentation in the 81-ha deltaic marsh at the head of the Big Lagoon embayment about 1 km east of the Big Lagoon Bog (Parker 1988). By surveying and measuring sediment from 70 cores, he estimated the minimum age of the marsh to be 315 years based on progradation rates. This estimated age is interesting since it was made before the tsunami of 1700 had been identified.

In 1992, concern over safety of the 55 students at the Big Lagoon Elementary School led Kathleen Fairchild to research the local tsunami risk and to develop an evacuation plan (Fairchild 2012). In 2000, her 13-year-old son undertook a study of the Big Lagoon Bog for the County Science Fair. He took core samples and found a layer of sand. He examined the sand in the core samples under the microscope and found the single-celled marine zooplankton, foraminifera, indicating the likely past occurrence of tsunami activity. His project was recognized with a Special Award at the Humboldt County Science Fair.

The strong sand lens and substrate containing marine foraminifera clearly indicates the Big Lagoon Bog was inundated by the great tsunami of January 1700. It has now been 318 years since that event. The next great Cascadia earthquake has a one-in-ten chance of occurring in the next 50 years, and that it may attain magnitude 9 (Atwater *et al.* 2005). The predicted future earthquake and resulting tsunami will likely again reform the coastal landscape. The subsequent fate of the Big Lagoon Bog is unknown.

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"Those plants won't grow in your climate"

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Something I have heard several times, and probably will continue to hear. When I first started, I believed this and stayed away from *Nepenthes* and grew just a few *Sarracenia* and several Venus flytraps. Then, one day, I was talking to a couple different growers from the southern United States, people who have become friends and a great source of information, and they gave me the ridiculous idea to try *Nepenthes* × *ventrata*.

At first, my plant struggled, but eventually it acclimated. Now, I grow several *Nepenthes* and have expanded into other genera as well.

Growing these bog plants in an area with extreme temperature swings, extreme seasons, and pesky critters is a challenge, but it is definitely achievable. Here in Montana, our winters are brutal. We get snow measured in meters, rather than centimeters, and temperatures well below -20°C. When summer finally rolls around, everything dries out, and temperatures will reach above 40°C, with little to no humidity.

Dionaea, *Sarracenia*, *Drosera capensis*, and *D. binata* are all grown relatively the same way. During the beginning of spring, I simply put them outside and use the tray method to water. I personally try to not let my trays go completely dry, but if they do, it will help with algae build up—just don't let your media go dry!!! Always be prepared to cover them during the beginning and end of the season. A mild frost is fine, but sometimes our temperatures will swing 30°C degrees in one day.

For *Dionaea* and *Sarracenia*, I use the fridge dormancy option. Once your plants are dormant, simply bag them up, with fresh, slightly moist peat (maybe a small spray of neem as well) and forget about them in the back of the fridge. I do this not to keep my plants cool, but rather in my climate, to keep them warm.

Drosera are brought inside and placed under lights. In some areas, *D. capensis* will form a hibernaculum, and be perfectly ok outside! I just personally haven't been willing to sacrifice one yet to find out if it will survive here.

Nepenthes such as *N.* × *ventrata* and *N.* "Miranda" can easily be acclimated to grow outside here. I simply hang them under a tree or under the roof of my porch during the peak of summer, where they still get a few hours of light, but are shaded during the heat of the day. I spray them with distilled water 2 or 3 times daily, and plant them in peat. The peat tends to hold moisture better than long fiber sphagnum. Once the temperatures are below 10°C, I bring the plants back inside.

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New Cultivars

Keywords: *Pinguicula* 'Riva', *Drosera binata* 'Ghost', *Nepenthes ampullaria* 'Black Widow', *Nepenthes ampullaria* 'Caramel Candy Stripe', *Nepenthes ampullaria* 'Lime Delight', *Nepenthes ampullaria* 'Chocolate Delight', *Nepenthes ampullaria* 'Cherry Delight', *Nepenthes ampullaria* 'Bronze Delight'.

Pinguicula 'Riva'

Submitted: 22 February 2018

The parents of *Pinguicula* 'Riva' (Fig. 1) are *P. agnata* (with scented flowers) × *P. gigantea* (to the best of my knowledge; the second parent may have been a *P. gigantea* × *P. emarginata*). This cross was done and the resulting seed germinated in late 2013 by me in San Francisco, California. This particular plant made its specialness apparent after about 2 years of growth under lights when it began flowering. The flower is approximately 2 cm wide by 2.5 cm long and is white with a bright yellow center which is surrounded by a flaring purple ring. The petals are 1 cm long, 7-9 mm wide, slightly ruffled, and the top 2 petals have irregular slightly serrated upper margins. The spur is 12 mm long, green and straight. The flower stalk is 18-20 cm long. And, the flower is scented, quite heavily in warmer conditions. The flower does not produce pollen or seed so it is sterile. The leaves of the plant are nice as well, ranging from 4-5.5 cm long and about 3 cm wide. The leaf shape is oblong egg-shaped with the rounded end distal from the central growth point. The color of the leaves ranges from pale green with burgundy tinting and margins to muted burgundy with green undertones. The margins of the leaf are slightly upturned. The leaves also have a noticeable shimmer and sparkle resulting from the "glue" production and glandular definition. The rosette may have anywhere from 7-12 leaves at a time. The plant does not produce dormant more succulent-like leaves but will propagate easily from pulling the carnivorous leaves. The plant divides itself readily and produces numerous (2-4) flowers at the same time almost constantly.

Figure 1: *Pinguicula* 'Riva' flowering plant (left) and flower (right).

Pinguicula 'Riva' is named for Riva Rubnitz, my mother.

At this time, plants are currently only available through me, but may soon be of limited availability through California Carnivores.

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Drosera binata 'Ghost'

Submitted: 2 May 2017

In 2014 *Drosera binata* 'Ghost' grew in my collection between apparently normal, seed propagated *D. binata*. I separated the plant for its striking white appearance and started to propagate it vegetatively by root cuttings and division. Usually the plant starts with very pale green to white petioles and leaves after winter dormancy (Figs. 2–4). During the growing season, also some normal green leaves emerge; therefore, the plant appears seasonally variable: either with all leaves white, white mixed with green, or for short periods even all green. Usually the white leaves predominate and even after short periods with only green leaves the white color returns. Since 2014, I forwarded the plant to some CP-friends for closer inspection and they all confirmed that the white petioles and leaves occur reliably for three years now. Therefore, the characteristics of this cultivar are stable and not just a seasonal "outlier" due to whatever conditions.

Apart from its color, *Drosera binata* 'Ghost' grows usually as T-form; however, mature plants temporarily develop also some dichotomous leaves, which are also either white or pale green. For cultivation, it needs the same conditions and requirements like a normal *D. binata* and the leaves die back during winter dormancy.

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Figure 2: *Drosera binata* 'Ghost' (center), *D. binata* "T-form" (left), and *D. binata* var. *dichotoma* (right). Photo by Klaus Ivanez.

Figure 3: *Drosera. binata* 'Ghost' with two developing dichotomous leaves. Photo by Klaus Ivanez.

Figure 4: *Drosera binata* 'Ghost' close up. Photo by S. Hartmeyer.

Six new *Nepenthes ampullaria* cultivars

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Submitted: 22 February 2018

Nepenthes ampullaria is a widespread species of lowland *Nepenthes* that occurs in Peninsula Malaysia, Borneo, New Guinea, Singapore, Sumatra, Thailand, and the Maluku Islands. Over the entirety of its range, *N. ampullaria* shows spectacular diversity in pitcher coloration, even though morphologically there is very little variation. These color varieties are stable in both the field and cultivation. Jacky Chiem of Chiemexotics, a *Nepenthes* nursery based in Vietnam, has amassed a collection of over 70 different clones and has previously registered *N. ampullaria* 'Black Miracle' and 'Black Pearl' (Carniv. Pl. Newslett. 46: 159, 2017), here six more of the most brilliant clones are formally registered as cultivars. The distinguishing features of these different cultivars focus on the striking combinations of pitcher and peristome color. All of these cultivars can only be propagated by cuttings from the original clones.

Nepenthes ampullaria 'Black Widow'

The lower pitchers have a very dark brown almost black coloration, with red markings, reminiscent of the red on black markings of the black widow (or red back) spider.

Nepenthes ampullaria ‘Caramel Candy Stripe’

The lower pitchers have a predominantly caramel color with a few brown markings, and the striking peristome is yellow with red candy stripes.

Nepenthes ampullaria 'Lime Delight'

The lower pitchers are almost pure dark brown/black with a few small lime green markings which contrast with the pure lime green peristome.

Nepenthes ampullaria 'Chocolate Delight'

The lower pitchers are chocolate brown with green markings and the peristome is a pure deep chocolate brown.

Nepenthes ampullaria ‘Cherry Delight’

The lower pitchers are brown with green markings and the peristome is beautiful cherry red color, evoking images of the popular Australian confectionary, Cherry Ripe®.

Nepenthes ampullaria 'Bronze Delight'

The lower pitchers are a red-bronze color with brown markings and the peristome is the same color on the outer margins and gradually fades to a yellow-bronze at the inner margin.

Names of carnivorous plant cultivars registered in 2017

Name	Publication	Date of registration
Cephalotus 'Round Leaf Big Daddy' A.Fisch	Carniv. Pl. Newslett. 46: 81 (2017)	20 Jul 2017
Dionaea 'Alternance' L.Blacher	Carniv. Pl. Newslett. 46: 84 (2017)	20 Jul 2017
Dionaea 'Jurasick' J.Mueller	Carniv. Pl. Newslett. 46: 38 (2017)	13 Apr 2017
Dionaea 'Lezard Vert' L.Blacher	Carniv. Pl. Newslett. 46: 83 (2017)	20. Jul 2017
Dionaea 'Red Pico-Teeth' S.Bonnet	Carniv. Pl. Newslett. 46: 157 (2017)	29 Dec 2017
Drosera 'Dr. Frankensnyder's Monster' J.Brittnacher	Carniv. Pl. Newslett. 46: 113 (2017)	2 Oct 2017
Drosera 'Nightmare' D'Amato	The Savage Garden: 171 (2013)	2 Oct 2017
Heliamphora 'Patasola' B.Tincher & J.Lei	Carniv. Pl. Newslett. 46: 157 (2017)	29 Dec 2017
Heliamphora 'Red Mambo' F.Boullanne	Carniv. Pl. Newslett. 45: 158 (2016)	27 Jan 2017
Nepenthes 'Black Miracle' R.Nunn	Carniv. Pl. Newslett. 46: 159 (2017)	29 Dec 2017
Nepenthes 'Black Pearl' R.Nunn	Carniv. Pl. Newslett. 46: 159 (2017)	29 Dec 2017
Nepenthes 'Mangomarginata' M.Aronesty	Carniv. Pl. Newslett. 46: 37 (2017)	13 Apr 2017
Pinguicula 'Niklas' O.Gluch	Carniv. Pl. Newslett. 45: 161 (2016)	27 Jan 2017
Pinguicula 'Red Starfish' M.Srba	Carniv. Pl. Newslett. 45: 162 (2016)	27 Jan 2017
Sarracenia 'Alicia' O.Bres	Carniv. Pl. Newslett. 46: 33 (2017)	13 Apr 2017
Sarracenia 'Berry Pastry' P.Faulisi	Carniv. Pl. Newslett. 46: 36 (2017)	13 Apr 2017
Sarracenia 'Brimstone' F.Passkiewicz	Carniv. Pl. Newslett. 46: 80 (2017)	20 Jul 2017
Sarracenia 'Cancan' M.Srba	Carniv. Pl. Newslett. 45: 159 (2016)	27 Jan 2017
Sarracenia 'Dionne' R.van Ool	Carniv. Pl. Newslett. 46: 34 (2017)	13 Apr 2017
Sarracenia 'Giant Cotton' O.Bres	Carniv. Pl. Newslett. 46: 78 (2017)	20 Jul 2017
Sarracenia 'Iamsatyricon' A.Amici	Carniv. Pl. Newslett. 46: 78 (2017)	20 Jul 2017
Sarracenia 'Mega Mouth' P.Faulisi	Carniv. Pl. Newslett. 46: 110 (2017)	2 Oct 2017
Sarracenia 'Mercury' C.Crow	Carniv. Pl. Newslett. 46: 77 (2017)	20 Jul 2017
Sarracenia 'Monks Head Hammerhead' J.Hummer	Carniv. Pl. Newslett. 46: 109 (2017)	2 Oct 2017
Sarracenia 'Red Beret' H.Carlton	Carniv. Pl. Newslett. 46: 112 (2017)	2 Oct 2017
Sarracenia 'Snow Lee' C.Yi	Carniv. Pl. Newslett. 46: 81 (2017)	20 Jul 2017
Sarracenia 'The Kraken' P.Faulisi	Carniv. Pl. Newslett. 46: 35 (2017)	13 Apr 2017
Sarracenia 'Tower of Terror' P.Faulisi	Carniv. Pl. Newslett. 46: 111 (2017)	2 Oct 2017
Sarracenia 'Whale Tail' M.Srba	Carniv. Pl. Newslett. 45: 160 (2016)	27 Jan 2017

Nomenclatural novelties (sensu ICN) published in Carnivorous Plant Newsletter (2017)

Name	vol(no): page
Drosera huegelii var. *phillmanniana* Y.-A.Utz & R.P.Gibson	46(4): 134
Pinguicula australandina Gluch	46(4): 123
Pinguicula nahuelbutensis Gluch	46(4): 127

12TH ICPS CONFERENCE

Sessions: 3-5 August 2018

Field Trip: 7-10 August 2018

The 12th International Carnivorous Plant Society Conference, hosted by The Bay Area Carnivorous Plant Society and California Carnivores, will be held at The Hyatt Regency Sonoma Wine Country in Santa Rosa, California, USA. Sessions will be held 3-5 August 2018 with optional field trips scheduled 7-10 August 2018.

Registration is required: see http://www.icpscon2018.com/conference-agenda.

Conference attendees will also be treated to the BACPS's annual show and sale which will be expanded to a two-day event and include vendors from around the world. Guests will enjoy the effort of many skilled growers in the show section which always include amazingly well-grown and often very rare plants in wonderful displays.

The conference ends with a banquet dinner at the Hyatt Regency Sonoma Wine Country (separate registration).

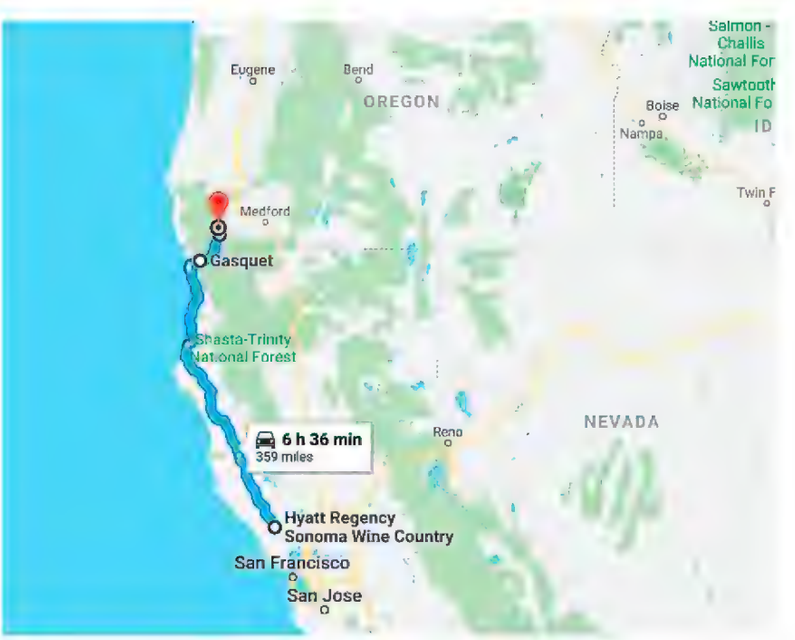
The field trip promises to be a fantastic experience. Led by Damon Collingsworth, Daniela Ribbecke, Gina Morimoto, Arthur Yin, Barry Rice, and Harry Tryon, participants will have an opportunity to see and photograph *Darlingtonia*, *Drosera*, and *Pinguicula* in northern California and southern Oregon. Along the way you'll see roadside cliffs where carnivores cling to the wet rocks, and populations of *Darlingtonia*.

The trip starts with an exploration of various *Darlingtonia* habitats in the Gasquet, California area including: The Wailing Wall, Panther Flat, *Darlingtonia* Trail, and various stops along Toll Road including The County Darlingtonia Preserve, Cedar Springs, and Darlingtonia Falls.

Friday will include an exploration of many sites in southern Oregon. Beginning with O'Brien, Oregon, participants will see sites along Lone Mountain Road and Whiskey Creek Bench.

The trip will then take participants to Cave Junction, Oregon, where they will visit the Oregon Caves National Monument and Preserve.

Considered by many to be the very best *Darlingtonia* site, the trip will culminate with the famous Days Gulch at Eight Dollar Mountain where the *Darlingtonia* march in a wide swath over 100 meters up the mountain.



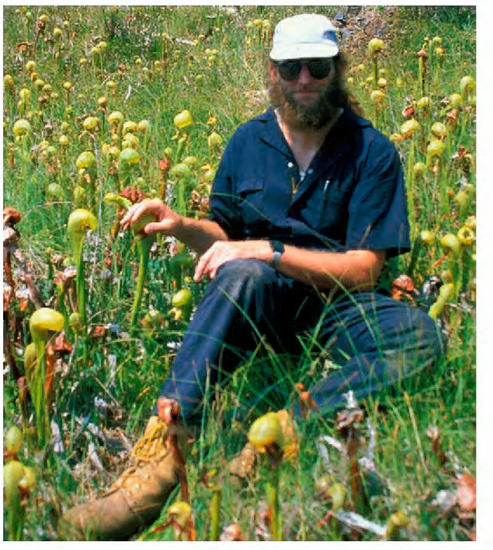
The Conference features three days of presentations from an all-star lineup of speakers from around the world covering a vast array of topics. Here are several of those:

Ulrike Bauer is a Research Fellow at the University of Bristol, UK, where she works on the biomechanics and ecology of plant-insect interactions. Much of her research to date has focused on prey capture mechanisms in pitcher plants. She has done field work in Brunei, Malaysia, and the Seychelles. Ulrike holds an undergraduate degree in Biology from the University of Würzburg, Germany, and a PhD in Zoology from the University of Cambridge, UK. In her spare time, she enjoys seeking pitcher plants in the wild, as well as nature photography and rock climbing.

Greg Bourke is the Curator Manager of the Blue Mountains Botanic Garden Mount Tomah, cool climate estate of the Royal Botanic Gardens and Domain Trust. Greg's interest in carnivorous plants is broad, ranging from plant breeding and cultivation to ecology and taxonomy. Greg has travelled extensively through Australia and South East Asia documenting and photographing carnivorous plants in the wild.

Andrej Pavlovič will discuss "Regulation of enzyme activities in carnivorous plants". Andrej is an Associate Professor of Plant Physiology at Palacký University in Olomouc, Czech Republic, where he studies electrical signaling and regulation of enzyme activities in carnivorous plants. His research on regulation of enzyme activities helps to understand how different genera of carnivorous plants sense the stimuli from insect prey, how they are translated into physiological response, and the similarity between plant defense reactions and botanical carnivory.

Andreas Fleischmann is curator of vascular plants at Munich Herbarium and research scientist at the Geo-Bio-Center LMU, University of Munich, Germany. His research on carnivorous plants includes evolution of the carnivorous syndrome in plants; fossil carnivorous plants; systematics and phylogeny, especially of *Drosera*, *Heliamphora*, and *Lentibulariaceae*; prey attraction, pollination biology, and mutualisms in carnivorous plants. He has traveled around the globe to see many of his favorite study objects in their natural habitats, and has authored more than a dozen scientific papers on carnivorous plants, including the descriptions of several new species. Apart from scientific interest in these fascinating plants, he has also grown carnivorous plants since his childhood.



Aaron M. Ellison will discuss "Scientific advances with Darwin's most wonderful plants in the world". Aaron is the Senior Research Fellow in Ecology in Harvard's Department of Organismic and Evolutionary Biology, Senior Ecologist at the Harvard Forest, and a semi-professional photographer and writer. He studies the disintegration and reassembly of ecosystems—including the *Sarracenia* microecosystem—following natural and anthropogenic disturbances; thinks about the relationship between the Dao and the Intermediate Disturbance Hypothesis; reflects on the critical and reactionary stance of Ecology relative to Modernism, blogs as The Unbalanced Ecologist, and tweets as @AMaxEll17. He is the author of A Primer of Ecological Statistics (2004/2012), A Field Guide to the Ants of New England (2012; recipient of the 2013 USA Book News International Book Award in General Science, and the 2013 award for Specialty Title in Science and Nature from The New England Society in New York City), Stepping in the Same River Twice: Replication in Biological Research (2017), and Vanishing Point (2017; a collection of photographs and poetry from the Pacific Northwest), and most recently, co-edited (with Lubomír Adamec) Carnivorous Plants: Physiology, Ecology, and Evolution (2018). On weekends, he works wood.

Robert Gibson will discuss "*Drosera* flower behaviour". Robert is a botanist who works at the New South Wales Office (NSW) of Environment and Heritage. In his free time, he studies carnivorous plants in cultivation at home and on travels in Australia and abroad. He has a particular interest in plants in the genus *Drosera* and completed a PhD study project on the *Drosera peltata* complex at the University of New England, Armidale, NSW, in 2006. Part of that PhD project examined the pollination ecology of some sundews, and this forms the basis of his discussion.

JN. Raisal Haq is a graduate student at Bogor Agricultural University, Indonesia. He is working on a project with a researcher from the Indonesian Institute of Science (LIPI) focused on *Nepenthes* conservation and exploring wild species from many areas in Indonesia. Working on his current research on geometric morphometric of *Nepenthes*, he seeks to analyze the pitcher shape variation with the eventual goal of creating a tool for automatic identification of *Nepenthes* (2-dimension and 3-dimension data set).

Tanabe (translated by Koji Kondo)
Larry Mellichamp
Hiraku Suda
Fernando Rivadavia

About our Hosts

The BACPS was founded by a small group of growers in the San Francisco Bay Area in 1988 and has grown to be one of the largest groups of carnivorous plant hobbyists in the world. It hosted its first ICPS conference at San Francisco's Fort Mason in 2000 and is excited to be hosting their second conference 18 years later in Santa Rosa with co-host California Carnivores and the help of the San Diego CPS and the Los Angeles CPS.

BAY AREA CARNIVOROUS PLANT SOCIETY

Co-host, California Carnivores, was started by Peter D'Amato, author of 'The Savage Garden' and one of the co-founders of the BACPS. Located a very short distance from the Conference, it now boasts the largest public display of carnivorous plants in the United States. Co-owner Damon Collingsworth has been instrumental in organizing this year's ICPS Conference.

For further information:
http://www.facebook.com/ICPSCon2018
http://www.bacps.org
http://www.icpscon2018.com
https://www.californiacarnivores.com/pages/about-us

To register for the conference, visit:
http://www.icpscon2018.com/conference-agenda